Claims

1. A method of binarising an image composed of pixels having respective intensity values, the method comprising:

(i) using prior knowledge about the image to derive a region of interest within it;

(ii) using prior knowledge about the image to derive an intensity range of pixels in the said region of interest;

(iii) obtaining a frequency distribution of the intensities within the said intensity range of pixels within the said region of interest;

(iv) using the said frequency distribution to derive an intensity threshold; and

(v) binarising the image by classifying pixels in the said region of interest according to whether their intensities are above or below the said intensity threshold.

2. A method according to claim 1 in which in step (iv), the threshold is found by deriving a valley in the frequency distribution within the range, and selecting the intensity threshold to correspond to the valley.

3. A method according to claim 2 in which the valley is found by determining the total intensities in a number of intervals defined in the range, and selecting the intensity threshold as an intensity within the interval having the lowest total intensity.

4. A method according to claim 3 in which the intensity threshold is selected as the mid-point of the interval having the lowest total intensity.

5. A method according to claim 1 in step (iv) the threshold is found by minimising a function which is a sum of the variances of the intensities below and above the threshold.

6. A method according to claim 5 in which the sum is a weighted sum defined based on two constants W_1 and W_2.

7. A method according to claim 6 in which, representing labelling the possible values of pixel intensity by an integer index i and their respective frequencies by $h(i)$, and writing the lower and upper intensities respectively as r_{low} and r_{high}, the weighted sum is given by

$$\theta_{RCWV}(W_1, W_2) = \max_{r_k}(\Pr(C_1)D(C_1)W_1 + \Pr(C_2)D(C_2)W_2),$$

where $Pr(.)$ denotes the class probability ($\Pr(C_1) = \sum_{i=r_{low}}^{r_k} h(i)$ and $\Pr(C_2) = \sum_{i=r_k+1}^{r_{high}} h(i)$), and $D(C_1)$ and $D(C_2)$ are given by:

$D(C_1) = (\mu_0 - \mu_T)^2$ and $D(C_2) = (\mu_1 - \mu_T)^2$, where $\mu_T = \sum_{i=r_{low}}^{r_{high}} i \times h(i)$, $\mu_0 = \sum_{i=r_{low}}^{r_k} i \times h(i)$ and $\mu_1 = \sum_{i=r_k+1}^{r_{high}} i \times h(i)$.

8. A method according to claim 1 in which step (iv) is performed by selecting the threshold as a function of parameters which maximise an entropy function which indicates the entropy of a fuzzy partition of the pixels into classes based on the parameters.

9. A method of processing an image which includes binarising it by a thresholding method according to any preceding claim, and then modifying the classification of one or more of the pixels by considering spatial relationships between the locations of the classified pixels.

10. A computer program product comprising a recording medium and programming instructions stored on the recording medium and readable by a computer system to cause the computer system to perform a method according to any preceding claim.

11. A computer system for binarising an image composed of pixels having respective intensity values, the system including:

(i) at least one data input device for a user to select a region of interest in the image and specify a frequency range within the frequency distribution of the intensities of pixels in the region of interest;

(ii) a processor arranged to obtain a frequency distribution of the intensities within the intensity range of pixels within the region of interest, use the frequency distribution to derive an intensity threshold; and binarise the image by classifying pixels in the region of interest according to whether their intensities are above or below the threshold.

12. A system according to claim 11 in which the processor is arranged to derive the threshold by deriving a valley in the frequency distribution within the range, and selecting the intensity threshold to correspond to the valley.

13. A system according to claim 12 in which processor is arranged to find the valley by determining the total intensities in a number of intervals defined in the range, and selecting the intensity threshold as an intensity within the interval having the lowest total intensity.

14. A system according to claim 13 in which the processor is arranged to select the intensity threshold as the mid-point of the interval having the lowest total intensity.

15. A system according to claim 14 in which the processor is arranged to select the threshold by minimising a function which is a sum of the variances of the intensities below and above the threshold.

16. A system according to claim 15 in which the sum is a weighted sum defined based on two constants W_1 and W_2.

17. A system according to claim 16 in which, representing labelling the possible values of pixel intensity by an integer index i and their respective frequencies by $h(i)$, and writing the lower and upper intensities respectively as r_{low} and r_{high}, the weighted sum is given by

$$\theta_{RCLWV}(W_1,W_2)=\max_{r_k}(\Pr(C_1)D(C_1)W_1+\Pr(C_2)D(C_2)W_2),$$

where $Pr(.)$ denotes the class probability ($\Pr(C_1)=\sum_{i=r_{low}}^{r_k}h(i)$ and $\Pr(C_2)=\sum_{i=r_k+1}^{r_{high}}h(i)$),, and $D(C_1)$ and $D(C_2)$ are given by:

$D(C_1)=(\mu_0-\mu_T)^2$ and $D(C_2)=(\mu_1-\mu_T)^2$, where $\mu_T=\sum_{i=r_{low}}^{r_{high}}i\times h(i)$, $\mu_0=\sum_{i=r_{low}}^{r_k}i\times h(i)$ and $\mu_1=\sum_{i=r_k+1}^{r_{high}}i\times h(i)$.

18. A system according to claim 11 in which the processor is arranged to select the threshold as a function of one or more parameters which maximise an entropy function which indicates the entropy of a fuzzy partition of the pixels into classes based on the parameters.

19. A system according to any of claims 11 to 18 in which the processor is further arranged to process the segmented image by modifying the classes to which each pixel is allocated by considering relationships between the locations of the pixels which have been classified.